

## HYDROLOGY

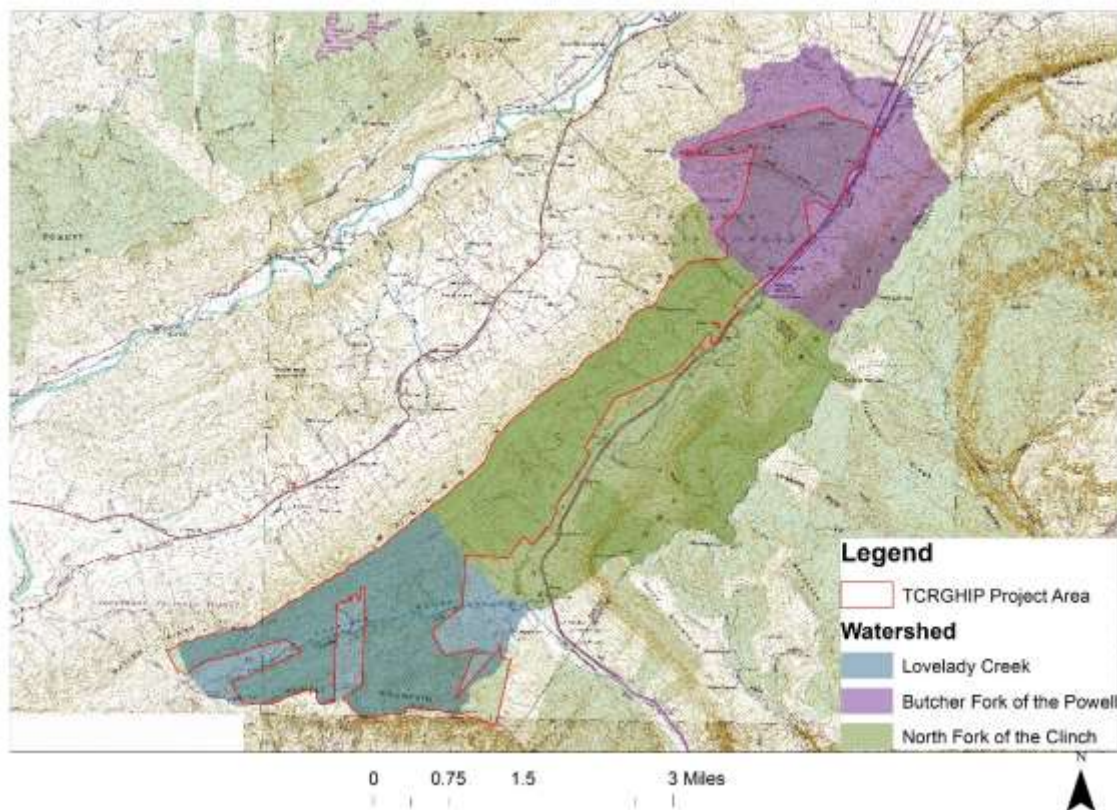
### **Issue(s) Related to this Resource:**

Effects to stream chemistry and health.

### **Scope of the Analysis:**

For the Action Alternative, the scope of the analysis for determining the effects on hydrologic resources includes the following watersheds: Butcher Fork of the South Fork of the Powell (3,068 acres), the North Fork of the Clinch River (4927 acres), and Lovelady Creek (2,538 acres).

Figure A. Watersheds affected by the Proposed Turkey Cove Vegetation Management Project.



### **Existing Condition:**

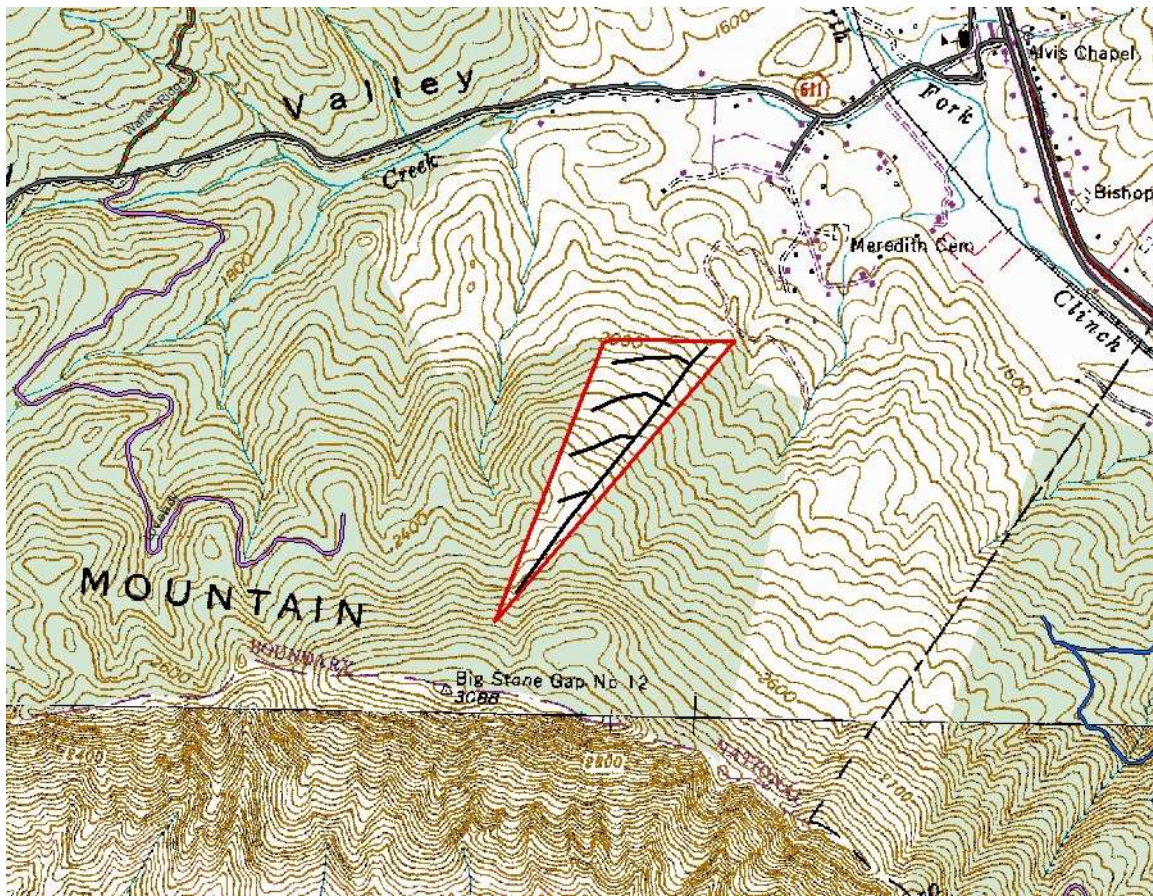
The Turkey Cove Vegetation Management Project is within 2 subwatersheds: the Upper North Fork of the Clinch River 060102050801 and Butcher Fork – South Fork of the Powell River 060102060201. The project area is drained by the smaller watersheds listed in the **Scope of Analysis** above. Annual precipitation over the project area averages approximately 48-52 inches in the project area (PRISM Climate Group 2014). The majority of the project area watersheds are in forested land cover; however, farms and single family homes exist on some private parcels.

### **Past and present actions that have affected the existing situation in the Turkey Cove Project Area -**

Past –A private tract was clearcut in the Lovelady watershed in 2017 (Figure 2). Sediment analysis was not performed, but the area was limited in size (approximately 40 acres) and the logging infrastructure was well placed.

On Forest Service lands, timbered areas have regrown and vary from 12 to approximately 20 years old. Sedimentation from the past timber harvest where significant new roads were not constructed would have returned to near background levels after approximately 5 years (Croke et al 2001) Timber harvest areas with significant new road construction would have returned to a new normal background for the area in 5 to 10 years that includes differences in sedimentation and runoff resulting from the road system.

Figure 2. Private logging tract (shown in red).



Present – Illegal ATV and full-size vehicle driving on gated roads is causing some sedimentation in the North Fork of the Clinch and Lovelady Creek watersheds in the project area. No other known activities are occurring in the project area or on adjacent private lands affecting the conditions in the watersheds.

### **Future Foreseeable Actions**



No known future foreseeable actions are slated to occur in the project area.

## **STREAM CHEMISTRY AND HEALTH**

### **Bioindicators**

Aquatic macroinvertebrate communities integrate the physical, chemical and biological components of the riparian ecosystem, and have been successfully used as bioindicators to monitor change and impacts (EPA 1989). A Macroinvertebrate Aggregated Index for Streams (MAIS) (ranging from a score of 0 to 18) incorporates nine ecological aspects (metrics) of the aquatic macroinvertebrate community to evaluate the current condition of a stream relative to others within the same ecological section (Smith and Voshell 1997). It also establishes a baseline to evaluate effectiveness of standards, guidelines and mitigation measures in preventing changes and impacts to the aquatic community.

Sample sites were selected downstream of management activity areas to monitor the impacts on stream health of projects including but not limited to timber sales and prescribed burns. Other samples were collected to create a baseline of stream conditions within the forest. Only samples collected from March through the first week in June were compared to minimize seasonal variability in structure of macroinvertebrate communities. Across the Forest, 1,857 samples were collected, analyzed and assigned an overall MAIS score (0-18). Of these samples, 76% were in the “good” and “very good” categories. An analysis of benthic and water quality data by Smith and Voshell (2013) indicated that the macroinvertebrate condition is significantly correlated to Acid Neutralizing Capacity (ANC) and pH, and that several specific benthic metrics (Ephemeroptera taxa, Percent ephemeroptera, Percent scrapers and HBI) are responding to changes in ANC and pH. The greatest values of the benthic metrics tend to occur at ANC values that are 20 or greater. As described above, roughly 20% of the sites had trends in ANC and pH; except for limed streams the majority of those trends were decreasing. These sites with low ANC or pH would have “poor” or “fair” MAIS scores.

Smith and Voshell (2013) also compared pre-activity macroinvertebrate metrics with post-activity metrics for streams located below timber harvests and prescribed burns at various locations across the Forest and concluded that “management practices are successful at reducing effects on aquatic organisms” from these activities. The results showed no decline in macroinvertebrates following timber sales or prescribed burns.

Macroinvertebrate samples have been collected from two project area streams beginning in 1994. Scores range from good to very good (see Table F below).

### **Lovelady Creek**

Lovelady Creek exhibits near-neutral to slightly basic pH and has sufficient buffering capacity to prevent episodic pH drops (Table E). Macroinvertebrate Stream habitat is present and MAIS scores range from Good to Very Good (Table F).

Streams were not resurveyed for this analysis. Follow-up visual surveys of representative reaches and areas that are likely to be impacted by sediment were performed by Chuck Lane, Clinch District Biologist in the summer of 2018. Lovelady Creek has some

sediment impacts on the lowest-gradient reaches, but overall exhibits a healthy range of riffles, runs, and pools.

Collier Hollow Creek (North Fork of the Clinch River)

Collier Hollow Creek exhibits near-neutral to slightly basic pH and has sufficient buffering capacity to prevent episodic pH drops (Table E). Macroinvertebrate Stream habitat is present and MAIS scores were Good (Table F).

Streams were not resurveyed for this analysis. Follow-up visual surveys of representative reaches and areas that are likely to be impacted by sediment were performed by Chuck Lane, Clinch District Biologist and in the summer of 2018. Collier Hollow Creek has some sediment impacts on the lowest-gradient reaches due to impacts from the failing banks along the old Collier Hollow Road (the FS closed this road in the 1990s to try to limit sedimentation from the road), but overall exhibits a healthy range of riffles, runs, and pools. Bank failure repair on the reach just above private property could improve watershed health downstream.

Table E. USFS Water Quality monitoring in the project area.

Stream Name	Sample Date	pH	ANC ueq/L	CA ueq/L	Mg ueq/L	Na ueq/L	K ueq/L	Cl ueq/L	NO <sub>3</sub> ueq/L	SO <sub>4</sub> ueq/L	Al ug/L	AlTotM onono (LAB) (ug/L)
Lovelady Creek	04/01/96	6.98	172.00	156.00	76.80	22.40	25.20	19.00	1.1	65		31
Lovelady Creek	04/27/98	7.11	177.00	148.00	72.90	23.20	19.70	20.80	6.1	62.7		3
Lovelady Creek	03/22/99	7.32	186.00	140.00	65.80	8.79	7.21	91.10	9.69	66.4		2
Lovelady Creek	03/15/00	7.21	170.00	114.00	63.70	14.30	11.60	20.40	4	72.2		4
Lovelady Creek	02/12/01	7.56	318.00	189.00	109.00	30.30	18.80	29.10	3.6	93.3		0BIDL
Lovelady Creek	01/29/02	7.20	152.00	116.00	67.70	17.20	19.80	20.20	5.81	67.2		7
Lovelady Creek	02/03/03	7.04	141.00	69.90	58.40	17.70	15.20	19.40	3.19	75.2		
Lovelady Creek	02/05/04	6.78	132.00	117.00	71.70	17.80	15.10	18.40	4.19	69.5		
Lovelady Creek	01/28/05	7.13	186.00	117.00	78.80	24.20	18.40	25.20	5.4	67.7		
Lovelady Creek	03/13/07	6.67	181.00	73.40	204.00	17.30	15.20	19.40	2.31	49.8		
Collier Hollow Creek	04/01/96	7.74	1120.00	1030.00	195.00	14.40	60.10	18.40	0BIDL	154		36
Collier Hollow Creek	04/27/98	7.83	1100.00	1040.00	179.00	36.10	20.40	19.10	13.5	142		38
Collier Hollow Creek	03/22/99	8.26	1280.00	818.00	173.00	30.70	7.70	20.00	26	156		37
Collier Hollow Creek	03/15/00	6.85	65.10	52.90	53.10	11.00	9.80	16.20	1.6	88.3		5
Collier Hollow Creek	02/12/01	8.07	1270.00	838.00	233.00	55.70	21.40	25.40	4.6	233		21
Collier Hollow Creek	01/29/02	8.39	669.00	634.00	188.00	44.80	27.90	21.50	11	151		3
Collier Hollow Creek	02/03/03	7.81	1140.00	903.00	213.00	41.80	19.00	26.00	13.8	170		
Collier Hollow Creek	02/05/04	7.57	411.00	599.00	151.00	30.90	19.60	38.90	9.19	127		
Collier Hollow Creek	01/28/05	8.04	1300.00	150.00	261.00	47.80	21.70	25.50	8.81	169		

Collier Hollow Creek	04/27/15	7.60	1749.00	1357.60	231.30	49.30	17.70	15.80	7.7	140.1	0	
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\* ANC= Acid Neutralizing Capacity, CA = Calcium, Mg = Magnesium, Na = Sodium,  
K = Potassium, Cl = Chloride, NO<sub>3</sub> = nitrate, SO<sub>4</sub> = Sulfate, Al = Aluminum, Cond=Conductivity, OBIDL=below detectable levels.

Table F. MAIS scores for the project area streams.

Stream Name	Date	MAIS Score	Assessment
Lovelady Creek	8/11/1994	15	Good
Lovelady Creek	4/23/1997	17	Very Good
Lovelady Creek	5/5/2000	18	Very Good
Collier Hollow Creek	5/7/1997	16	Good

### **Direct, Indirect and Cumulative Effects:**

#### **Effects from Herbicide Application**

#### **Herbicides Proposed for Use in the Turkey Cove Project Area**

For a complete discussion of the effects of the application of herbicides on soil and water resources, consult the Environmental Assessment of Forest-Wide Non-Native Invasive Plant Control (Herbicide EA) George Washington and Jefferson National Forests (2010). The following italicized descriptions are taken directly from the Environmental Assessment for Forest-Wide Non-Native Invasive Plant Control prepared for the George Washington and Jefferson National Forests (2010).

***Glyphosate*** is a non-selective, broad spectrum herbicide that can be used to control many grasses, forbs, vines, shrubs, and tree species. Specific formulations of Glyphosate have been labeled for aquatic application. Formulations labeled for aquatic sites can be effective on both emergent aquatics and shoreline vegetation. This chemical is a growth inhibitor that can be applied through direct foliar application, stem injection, and cut-surface application. It has been proven effective on a wide variety of non-native invasive plant species. Commercial brand names include, but are not limited to Accord™, Roundup™, and Rodeo™. Typical application rate for Forest Service programs is 2.0 lb a.e./acre with a range of 0.5 to 7.0 lb a.e./acre.

***Imazapyr*** is a selective herbicide that is used primarily in the control of hardwood trees and some species of grasses. This chemical is a plant protein production inhibitor that can be absorbed either through roots or foliage, or injected directly into the stem, and works systemically throughout the target plant. It has been proven effective in the control of tree of heaven, princess tree, mimosa, autumn olive, privet, and multiflora rose. Used in combination with Triclopyr or Glyphosate can increase target specificity. Commercial brand-names include, but are not limited to Arsenal™ and Chopper™. Typical application rate for Forest Service programs is 0.45 lb a.e./acre with a range of .03 to 1.25 lb a.e./acre.

***Triclopyr*** is a selective herbicide that controls many species of herbaceous and woody broadleaf weeds, but has little to no effect on grasses. This chemical acts as a growth regulator and can be applied as a direct foliar application, basal spray, stem injection, or cut-surface treatments. There are two primary formulations of Triclopyr; an ester and an amine. Each formulation is useful for certain applications methods. Specific formulations of Triclopyr have been labeled for aquatic application. Formulations labeled for aquatic sites can be effective on both emergent aquatics and shoreline vegetation. It has been proven effective on a wide variety on non-native invasive plant species. Commercial brand-names include, but are not limited to Tahoe 3A™, Tahoe 4E

4<sup>TM</sup>. Typical application rate for Forest Service programs is 1.0 lb a.e./acre with a range of 0.05 to 10.0 lb a.e./acre.

**Adjuvants and Dyes:** An adjuvant is any compound that is added to an herbicide formulation or tank mix to facilitate the mixing, application, or effectiveness of that herbicide. Adjuvants are already included in the formulations of some herbicides available for sale (e.g. RoundUp®), or they may be purchased separately and added into a tank mix prior to use. Adjuvants are chemically and biologically active compounds, and they may improve the effectiveness of the herbicide they are added to, either increasing its desired impact and/or decreasing the total amount of formulation needed to achieve the desired impact. Some herbicides require the addition of an adjuvant to be effective. Some adjuvants enhance the penetration of herbicide into plants by ensuring adequate spray coverage and keeping the herbicide in contact with plant tissues, or by increasing rates of foliar and/or stomatal penetration (Tu et al. 2001). Dyes (such as Turfmark<sup>TM</sup>) are mixed with herbicide and stain the area where herbicide is applied, allowing the applicator to see treated areas. This results in more accurate treatment and reduces potential for using more herbicide than necessary. There is no universal adjuvant that can improve the performance for all herbicides, against all weeds, or under all environmental conditions. The herbicide and adjuvant selected and the relative amounts used must be tailored to the specific conditions of each application. The primary herbicide adjuvants being considered are:

- Vegetable oil carrier group (derived from plants) or mineral oil carrier group (derived from petroleum products) – non-ionic surfactants (such as JBL Oil Plus<sup>TM</sup> or JBL Oil Improved Plus<sup>TM</sup>) that reduce surface tension and improve spreading, sticking and herbicide uptake.
- Limonene spreader group – non-ionic surfactants (such as Cide-Kick<sup>TM</sup> or Organic- Kick<sup>TM</sup>) which are wetting agents, activators, and penetrants all in one and are byproducts of the citrus industry.

The U.S. Environmental Protection Agency (EPA) regulates the inclusion of certain ingredients in adjuvant formulations, but it does not stringently test and regulate the manufacture and use of adjuvant products (as they do for herbicides and other pesticides). As such, there is little information on the effects of these different adjuvants, other than that provided by the manufacturer. An herbicide label may specify what types of adjuvant are appropriate or advisable to use with that herbicide, but it will not suggest specific brands. Therefore, there is no good single resource or system to determine which specific adjuvant product (if any) to use for each application situation (Tu et al. 2001).

All treatments undertaken would conform to policy, laws and regulations, and Forest Plan standards and guidelines. Mitigation measures listed in Chapter 2.3 of the Herbicide EA (pp. 20-28) would additionally minimize soil and water contamination by herbicides.

Effects and associated risks of all herbicides, except fosamine ammonium (USDA Forest Service 1989), proposed for use have been assessed by Syracuse Environmental Research Associates, Inc. (SERA 2003a, 2003b, 2004a, 2004b, 2004c, 2004d, 2004e, 2005). The complete text of these documents can also be found at:

<http://www.fs.fed.us/foresthealth/pesticide/risk.shtml>.



Direct effects to soil and water resources may include some limited drift from fine mists during application. Once in the soils, some herbicides can migrate via gravity, leaching, and surface runoff to other soils, groundwater, or surface water. To determine the level of risk for accumulation of herbicide residues on soils and possible contamination of ground and surface water, factors such as persistence (measured in half-life), mobility, and mechanisms for degradation have been reviewed (Appendix C, Herbicide EA). However, most of the herbicide treatments would be applied directly to targeted species and relatively little herbicide would make contact with the soil.

### Sedimentation

#### **Effects to Streams from Sedimentation**

Virginia State Code 9VAC25-260-20 states that:

*State waters, including wetlands, shall be free from substances attributable to sewage, industrial waste, or other waste in concentrations, amounts, or combinations which contravene established standards or interfere directly or indirectly with designated uses of such water or which are inimical or harmful to human, animal, plant, or aquatic life.*

*Specific substances to be controlled include, but are not limited to: floating debris, oil, scum, and other floating materials; toxic substances (including those which bioaccumulate); substances that produce color, tastes, turbidity, odors, or settle to form sludge deposits; and substances which nourish undesirable or nuisance aquatic plant life.*

Sediment can cause turbidity, and is therefore subject to this standard. In addition, Virginia's antidegradation policy (9VAC25-260-30) applies to this area. That policy says that actions may not interfere with or become injurious to existing beneficial uses unless the State Water Control Board determines that such action is socially or economically justified.

Sediment is also subject to the nonpoint source pollution regulations for Virginia. These regulations require the voluntary application of Best Management Practices (BMP's) to control sedimentation during timber management activities. The Virginia Department of Forestry's handbook of BMP's for forestry (revised 2002) lists the "voluntary" BMP's. Standard 206 of the Forest Plan requires the use of the Virginia BMP's, and the Forest Plan lists specific BMP's to provide additional resource protection. Finally, standards set by the "Federally Listed Endangered and Threatened Mussel and Fish Conservation Plan" developed for the Jefferson National Forest in consultation with the US Fish and Wildlife Service, were incorporated into the Jefferson National Forest Land and Resource Management Plan. These standards provide additional protections to prevent sediment impacts to downstream T and E mussel and fish species. See the mitigation section of this EA for those Forest Plan standards and/or State BMP's that were used in alternative design to reduce sedimentation.

All Forest Plan standards appropriate to this management area meet or exceed the Virginia BMP's for forestry activities. The Forest has initiated a monitoring program to evaluate

the effectiveness of the standards. The result of this program will be a feedback process to continually adjust standards as needed to improve effectiveness.

The Virginia Department of Forestry conducted water quality monitoring in association with timber harvests from 1989 to 1996 (Va. Dept. of Forestry, 1998). At sites in the mountains, Piedmont, and coastal plain, water temperatures were taken at 10-minute intervals, and water samples were collected automatically before, during, and after storm events, both upstream and downstream from logging. Aquatic macroinvertebrates were also sampled periodically. This monitoring showed that, when forestry BMP's are properly implemented, timber harvests can be accomplished without a large or persistent increase in sediment or stream water temperatures, or a shift in macroinvertebrate species composition.

Some sediment occurs naturally in all stream systems and is part of the natural geologic processes. Natural watershed disturbance regimes of fire, flood, insect, and disease result in a range of natural variability of sediment to which the stream channel has adjusted. However, human caused soil disturbing activity such as road construction activities, log landings, skid roads, and skid trails can produce volumes and rates of sediment delivery to streams that are in excess of the stream's ability to accommodate it. Excess sediment in streams can coat the stream bottom, fill pools, and reduce the carrying capacity of the stream for fish and stream insects. Fine sediment can fill the voids between gravel particles in the streambed, reducing the movement of aquatic insects, water and oxygen. The effects of sediment delivered to a stream channel diminish as watershed size increases. Most vulnerable are small sensitive headwaters catchments where concentrated timber harvest activity can have profound results.

In reality, there is a great deal of variability of a watershed's sediment yield between years (interannual variability). Sediment yield is much greater during high runoff years with more stormflow to erode and transport sediment. Conversely, sediment yield is much less during drought years when high flows may be less than bankfull. Data from the USGS gage on the Clinch River at Speers Ferry provides an expression of the variability of annual sediment yield. For the 62 years with flow and sediment data, each year's percent difference from the long term mean ranges from + 143 percent to - 100 percent. A change of annual sediment yield of plus or minus 52 percent represents one standard deviation from the long term mean, and values less than 52 percent are interpreted as being within the range of interannual variability.

The effect that naturally occurring forest fires or prescribed burns can have on increased sediment production within a watershed depends on burn intensity. Low intensity burns do not scorch the soil organic layers nor do they burn the roots of existing vegetation, which starts to re-grow during the next growing season. No bare mineral soil is exposed as the result of the burn. Research on wildfire and prescribed burning indicates that low intensity or "cool" burns result in only minor increases in erosion and sedimentation. Beschta (1990) observes that

*Where organic matter comprising the forest floor is only partially consumed by fire, the effects of fire upon surface erosion processes may be minimal.... Relatively "cool" burns should have little impact on erosion and sedimentation, regardless of general watershed slope.*

This observation from Oregon is supported by similar conclusions from Anderson and others (1976), Douglas and Van Lear (1983), Neary and Currier (1982), and Van Lear and others (1985). Hand line construction for this project will be accomplished using leaf blowers and rakes. Mineral soil will be relatively undisturbed. Accordingly, this activity will have little impact on erosion and sedimentation. Dozer line will be single-blade wide, and as the analysis shows, these kinds of narrow, transient sediment impacts are not significant.

A sediment model was used to estimate the tons of sediment produced by each road, landing, or excavated skid trail, and delivered to respective stream channels. The modeling approach is largely based on the USDA Forest Service "Guide for Predicting Sediment Yield from Forested Watersheds" (1981). This guide tiers to another procedural guide 'An Approach to Water Resources Evaluation of Non-Point Silvicultural Sources' and abbreviated as WRENSS (EPA 1980). The procedure assumes a basic road erosion rate as determined from research data from North Carolina and West Virginia (Swift 1984; Kochenderfer and Helvey 1984). The research data expresses the tons per acre moved from the road during the first year after construction. This unit rate is multiplied by the disturbed area in acres to obtain unmitigated road erosion in tons. This figure is then adjusted for factors of geology and soils, road gradient, and mitigation to obtain an adjusted value of total road erosion. Total road erosion is then delivered to the stream channels based on aggregated sediment delivery ratios from the WRENSS document. The sediment delivery ratio for each road segment is calculated using factors based on side slope, soil texture, distance from the road to the nearest channel or drainway, and also factors of surface roughness, slope position, percent ground cover, and slope shape. These combined factors are translated into a Sediment Delivery Index that represents the portion of eroded material that is actually delivered to a stream. When multiplied by road segment, landing, skid trail, and prescribed burn fire line erosion, it gives an estimate of tons of sediment delivered to the adjacent stream channel at the time of the soil disturbing activity (first year). This sediment increase is compared with existing annual sediment yield from each watershed as determined by data from Patric, Evans, and Helvey (1984) and displayed as a percent increase over existing.

Rates of soil erosion and sedimentation are greatest at the time of soil disturbing activity and decrease as the soil stabilizes and vegetation begins to grow. Second year sediment rates are estimated to be only 35 percent of first year rates. After four years, sediment rates have usually returned to pre-disturbance levels. All these projected levels are based on the cessation of road traffic. Illegal or continued administrative use will extend the amount of time it takes to return to near-background.

Sediment modeling is based on a number of assumptions that may not be accurately reflected on the ground. The results provide very rough approximations of the changes in sediment delivery that might be expected as a result of proposed activities. Nevertheless, they allow a comparison of the impacts of various alternatives and provide a measure of relative risk to the aquatic ecosystem. The model assumes that Forest Plan standards and guidelines as well as Virginia Best Management Practices for Forestry will be implemented. It assumes a "normal" runoff and sediment year.

#### Lovelady Creek

The predicted sediment increases from the proposed action are 3.1 percent over background for this watershed. No changes in stream bed composition should occur. The increase in sediment is small when compared to the background values and well within the interannual variability of the system. Aquatic habitat quality or complexity should not be reduced from sediment related to the project. There should be no measurable or observable direct, indirect, or cumulative effects to Lovelady Creek or its tributaries in the project area, or to any reaches downstream. Reducing or eliminating impacts from the illegal trails should be a priority to lessen the impacts these areas are having on the stream.

#### North Fork of the Clinch River

The predicted sediment increases from the proposed action are 3.1 percent over background for this watershed. No changes in stream bed composition should occur. The increase in sediment is small when compared to the background values and well within the interannual variability of the system. Aquatic habitat quality or complexity should not be reduced from sediment related to the project. There should be no measurable or observable direct, indirect, or cumulative effects to the North Fork of the Clinch River or its tributaries in the project area, or to any reaches downstream.

#### Butcher Fork of the Powell River

The predicted sediment increases from the proposed action are 0.7 percent over background for this watershed. No changes in stream bed composition should occur. The increase in sediment is small when compared to the background values and well within the interannual variability of the system. Aquatic habitat quality or complexity should not be reduced from sediment related to the project. There should be no measurable or observable direct, indirect, or cumulative effects to the Butcher Fork of the Powell River or its tributaries in the project area, or to any reaches downstream.

#### **Cumulative Effects Boundary for Effects to Project Area and Downstream Aquatic Organisms**

As a result of the sediment analysis, the lower cumulative effects boundaries for discussion of effects to aquatic organisms is set at the confluence of Lovelady Creek and the North Fork of the Clinch River (NFCR) for the NFCR and on Wildcat Creek where it passes under SR 609 for the BFPR. The effects are immeasurable and indistinguishable from background levels below these points in each watershed.

### Works Cited

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Croke, J., Hairsine, P., and P. Fogarty. 2001. Soil recovery from track construction and harvesting changes in surface track infiltration, erosion and delivery rates with time. *Forest Ecology and Management* 143: 3-12.